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(54) IMPROVEMENTS IN OR RELATING TO FILTER ELEMENTS

(71) I, THE SECRETARY OF STATE FOR DEFENCE, London, do hereby declare the invention, for I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in the construction of filter elements formed from a woven or non-woven cloth containing or consisting of activated fibrous carbon. Such cloth is referred to hereinafter as activated carbon cloth.

As described in co-pending United Kingdom Patent Application No. 37529/70 (now granted Patent No. 1,376,888), activated fibrous carbon has advantages over particulate activated carbon for use in gas, especially air, filters, since it is largely self-supporting, has little or no tendency to "settle" and in general has superior dynamic absorptive capabilities. Layers of the activated fibrous carbon, normally in the form of woven or non-woven cloth, may be assembled in a filter casing perpendicular to the direction of flow of the gas stream to be filtered and may be preceded by or interspersed with a particulate filter material such as glass fibre. Alternatively, as described in United Kingdom Patent Application No. 60483/70 (now granted Patent No. 1,376,888), layers of activated carbon cloth may be arranged parallel to the direction of gas flow and sealed to each other in pairs at alternate ends so that gas entering the stack of cloth layers at one side may leave at the opposite side only after passing through at least one layer of cloth. Copending United Kingdom Patent Application No. 31475/72 (Serial No. 1,429,476) describes a novel type of filter using layers of activated carbon cloth parallel to the flow direction and open at both ends, the gas adsorption being achieved as the gas flows over the surface of the carbon cloth layers which may be separated by an air gap or a particulate filter.

Whilst activated carbon cloth is largely self-supporting, its assembly into a useful filter element normally requires some means of containing a plurality of layers and often some support for large areas of cloth which would otherwise move independently to an undesirable extent when subject to applied pressure. Such containment and/or support means reduces the inherent flexibility of the carbon cloth, generally resulting in a rigid filter element, and may also restrict gas flow through the filter.

It has now been found that filter elements comprising a plurality of layers of activated carbon cloth may readily be formed by contacting adjacent layers with discrete particles of a thermoplastic material and heating to bond the particles to at least one of the adjacent cloth layers. The particles of thermoplastic material may be used to bond the carbon cloth layers together thereby producing a single filter element retaining a large proportion of the inherent flexibility possessed by the carbon cloth. According to the present invention, therefore, a filter element comprises a plurality of layers of activated carbon cloth wherein adjacent layers of cloth are separated one from the other by spacing particles which comprise thermoplastic material bonded to at least one of the adjacent cloth layers.

The thermoplastic material will normally be a thermoplastic polymer such as polyvinyl chloride, polypropylene or, especially, polyethylene.

The activated carbon cloth is preferably prepared by the process described in United Kingdom Patent Specification No. 1,301,101.

Although each spacing particle may, in some cases, be bonded to only one layer of carbon cloth, the spacing particles should preferably bond together adjacent layers of carbon cloth, so that the layers of cloth may support each other. In this way the need for other support may be avoided, although it may sometimes be desirable to insert a layer of other material such as perforated cotton scrim, between the layers of activated carbon colth in order to increase the flexural strength, or over the outer layers in order to increase abrasion resistance. In some

cases it may be advantageous to include one or more layers of material capable of acting as a particle filter in the filter element. A paper made from glass fibre is particularly suitable for this purpose.

Numerous variations of design are possible in filter elements in accordance with the present invention since various unusual shapes may readily be cut and layers of activated carbon cloth may be joined in pleated or folded arrangements. Thus, for example, flexible filter elements may be constructed, which, when bent, conform exactly to the contours of a respirator face-mask.

The size of the spacing particles will depend on the nature of the filter element being constructed. In filter elements designed for conventional perpendicular gas flow, the particle size will not be critical provided it exceeds the magnitude of surface variations of the cloth and is not so large as to cause excessive blockage of the useful filter area. Particle sizes of the order of 0.1 mm are generally convenient. In parallel flow filters however, the particle size is more critical since it determines the spacing of the carbon cloth layers. The particle size will normally be in the range 0.5 to 1.0 mm although smaller or larger particles may be used depending on the desired spacing of the cloth having regard to the adsorption characteristics of the gas to be passed into the filter. The spacing particles should normally cover the minimum area of carbon cloth sufficient to provide adequate adhesion and strength. This varies with the style of filter. When using particles of thermoplastic material of the the order of 0.1 mm size, the quantity should generally be about 1 gramme per square metre although wide variations between, for example, 0.1 and 10.0 grammes per square metre are possible. With particles of size in the range 0.5 to 1.0 mm, the density of distribution of the particles is suitably about 1 gramme/square metre.

It will be appreciated that the particles of thermoplastic material will not normally contribute to the filtration effect of the filter element. According to a further feature of the invention however, the spacing particles may further comprise activated carbon. This is conveniently achieved by first bonding a layer of thermoplastic particles to the cloth, e.g. by heating, then sprinkling on a layer of activated carbon granules, followed by further heating so that the activated carbon granules adhere to the thermoplastic particles. The activated carbon granules will not only assist in maintaining the required air gap as described in the United Kingdom Patent Application No. 31475/72, (Serial No. 1,429,476), but will also increase the overall capacity and efficiency of the filter. The activated carbon material should normally be used in an amount to give a density of distribution of about 100 grammes per square metre between cloth layers when using granules having a size of about 1.0 mm.

Specific examples of filter elements in accordance with the present invention will now be described with reference to the drawings filed with the Provisional Specification in which:—

Fig. 1 shows in section a portion of a filter element in accordance with the present invention; and

Fig. 2 shows in section a schematic drawing of a parallel flow filter containing a filter element in accordance with the present invention.

Referring to Figure 1, the filter element comprises substantially rectangular layers of activated carbon cloth 1, separated by spacing particles of polyethylene 2 which are bonded at their extremities 3 adjacent to the carbon cloth into the weave of the cloth. The resulting filter element may be used either as a perpendicular flow filter by fitting into a suitable container which provides edge sealing whilst leaving the outer cloth faces exposed, or as a parallel flow filter by fitting the element with plates covering the outer cloth faces and with suitable edge sealing means along one pair of opposed side edges of the element thus allowing the gas to flow between the layers of cloth.

A filter element such as that shown in Figure 1 may be prepared by producing a stack of active carbon cloth layers, each layer being sprinkled with particles of polyethylene, having an average particle size of 0.1 mm, before adding a further layer of activated carbon cloth. After adding a final cloth layer the entire stack is heated to about 130°C, lightly pressed at about 1 gramme per square centimetre (0.014 psi) and cooled.

Figure 2 shows an arrangement essentially similar to that shown in Figure 4 of co-pending United Kingdom Patent Application No. 31475/72. (Serial No. 1,429,476). A parallel flow filter comprises a stack of annular layers of activated carbon cloth 11 contained between a circular metal plate 13 and an annular metal plate 14. Each layer of activated carbon cloth 11 has particles of polyethylene 12 of average size 1.0 mm bonded to it at points distributed about its surface. In this case, however, the polyethylene particles need only be bonded to one carbon cloth layer to act only as spacers between the layers, the filter element being held together by suitable external clamping means (not shown).

The filter shown in Figure 2 may readily be constructed by sprinkling particles of polyethylene, approximately 1 gramme per square metre, on to single large sheets of activated carbon cloth and heating to 130°C. The annular layers 11 are then cut from

these large sheets and built into the stack. The particles of polyethylene act as spacers and no further spacing material is required, although other material such as particulate filter material, may be inserted between at least some of the carbon cloth layers.

In particular, granules of activated carbon may be applied to the cloth after application of the polyethylene particles, and bonded to the polyethylene particles by heating. The active carbon granules may assist in achieving the desired spacing of the cloth layers, and furthermore will increase the adsorbtive capacity of the filter.

WHAT I CLAIM IS:—

1. A filter element comprising a plurality of layers of activated carbon cloth wherein adjacent layers of cloth are separated one from the other by spacing particles which comprise thermoplastic material bonded to at least one of the adjacent cloth layers.

2. A filter element according to Claim 1 wherein the adjacent layers of cloth are bonded together by the said spacing particles.

3. A filter element according to Claim 1 or Claim 2 and further including a layer of permeable reinforcing material.

4. A filter element according to any preceding claim and further including a layer of material designed to act as a particle filter.

5. A filter element according to Claim 4 wherein the material designed to act as a particle filter is glass fibre.

6. A filter element according to any preceding claim wherein the thermoplastic material is a thermoplastic polymer.

7. A filter element according to Claim 6 wherein the thermoplastic polymer is one selected from polyvinyl chloride, polypropylene and polyethylene.

8. A filter element according to any of the preceding claims wherein the spacing particles also comprise activated carbon.

9. A filter element according to claim 8, wherein the spacing particles comprise activated carbon in the form of granules.

10. A filter element according to claim 9, wherein the carbon granules have a size of about 1.0 mm. and are distributed between cloth layers at a density of about 100 grammes per square metre.

11. A filter element substantially as hereinbefore described with reference to Figure 1 or Figure 2 filed with the provisional specification.

12. A filter incorporating a filter element as claimed in any preceding claim, wherein the cloth layers are substantially perpendicular to the intended direction of gas flow.

13. A filter according to Claim 12 wherein the spacing particles comprise polyethylene particles having a size of the order of 0.1

14. A filter according to Claim 13 wherein the areal density of distribution of the polyethylene particles between the cloth layer is from 0.1 to 10.0 grammes per square metre.

15. A filter according to Claim 14 wherein the areal density of distribution of the polyethylene particles between cloth layers is about 1 gramme per square metre.

16. A filter incorporating a filter element as claimed in any one of the Claims 1 to 11, wherein the cloth layers are substantially parallel to the intended direction of gas flow.

17. A filter according to Claim 16 wherein the spacing particles comprise polyethylene particles having a size from 0.5 mm to 1.0 mm.

18. A filter according to Claim 17 wherein the areal density of distribution of the polyethylene particles between the cloth layers is about 1 gramme per square metre.

19. A filter substantially as hereinbefore described with reference to Figure 1 or Figure 2 filed with the Provisional Specification.

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1476761 PROVISIONAL SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original, on a reduced scale*

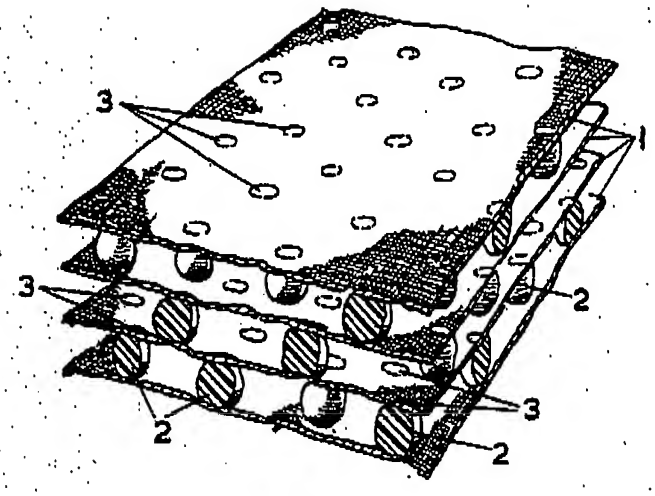

FIG. 1.

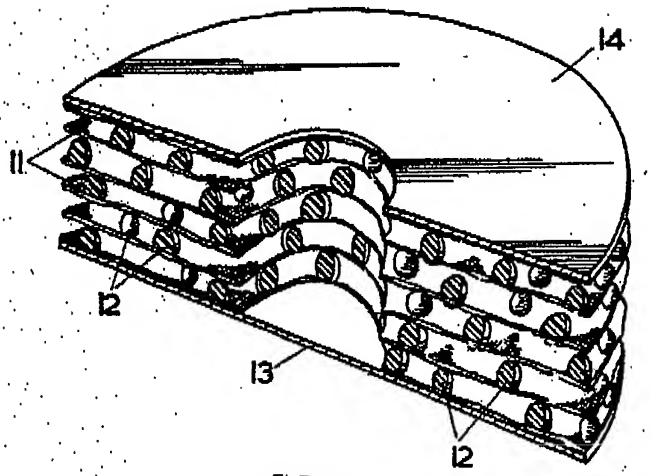

FIG. 2.